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Olive Notes
Tulare County

Innovative Progress in the Mechanical Harvest of California Black Ripe Olives

Introduction

The economic sustainability and consequent longevity of California's historic "black ripe" table olive industry is challenged by the crippling cost of hand-harvest, a cost that often exceeds 50-75% of gross return. Hand harvest costs are volatile due to dynamics in annual and regional crop load and labor supply, and are also influenced by competition between growers and producers of other commodities. Development of a mechanical harvesting method offers the only economically-feasible solution to long-term industry sustainability. Three interrelated factors contribute to successful development of mechanical harvest technologies: i) design of fruit-removal and catch methods that do not adversely affect fruit or tree, ii) tree training and pruning to facilitate mechanized harvest, and iii) design or discovery of abscission agents to enhance fruit loosening and removal from the tree. Although an abscission agent has yet to be found, fruit removal technologies and tree training innovations have fostered the advent of mechanical harvest for the table olive industry.

Impediments to Mechanical Harvest

Both the botany of the olive and industry processing standards impose impediments to implementation of mechanical harvest. 'Manzanillo' olives, the major cultivar utilized for black ripe processing, are harvested when physiologically immature; consequently, they require a higher "pull force" (~0.5 kg) for removal then mature fruit. Most traditional CA table olive orchards are comprised of tall trees (≥ 18 ft) with wide canopies (12-18 ft), and fruit is borne on the ends of multiple flexible pendulous shoots. Additionally, the fruit bruise easily, and excess damage adversely affects fruit value and grower return.

Developing and Evaluating Mechanical Harvesters

A multi-phase sequence is generally employed for either development of a new mechanical harvester or adaptation of an existing harvest technology from another crop. Fruit removal techniques are developed and then tested to ensure lack of damage to the commodity and the tree. Then a mobile platform is built to hold the driver and a catch frame and the final unit is tested for harvester efficiency and operating parameters (i.e. ground speed, harvest rate, etc). Harvester efficiency is best conceptualized in comparison to hand harvest, with hand harvest considered to achieve nearly 100% fruit removal, an overestimate-but appropriate standard for comparison. University of California Agricultural Economist, Dr. Karen Klonsky, estimates that a mechanical harvesting cost of $150/ton requires approximately 80% final harvester efficiency for economic feasibility. Studies conducted on two harvesters in 2012 suggest that harvester efficiency is nearing the 80% goal.

Two Mechanical Harvesting Technologies Identified for Olive

Trunk shaker and canopy-contact harvesters utilized in other cropping systems have been modified for use on olive with minimal tree and fruit damage. Trunk shaker technology may be more applicable to olive trees with a smooth trunk, upright growth habit, and short scaffolds, whereas canopy-contact harvesters may be better suited for hedgerow plantings managed with mechanical pruning. Evaluations conducted by UC researchers

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U.S. Department of Agriculture, University of California, and Tulare County Cooperating

have demonstrated at least 75% fruit removal efficiency by both harvester types, and sensory and consumer panels are unable to distinguish between hand-harvested and mechanically-harvested fruit.

Tree Shaker

A 2012 non-experimental evaluation of the Erick Nielsen Enterprises Inc. olive trunk shaker demonstrated an approximate 77.5% harvest efficiency in a mature, 180 tree/acre 'Manzanillo' block. Over the two years preceding this evaluation, the block was adapted for mechanical harvest by hand-pruning limbs likely to interfere with the harvester and mechanically hedging to reduce tree size. When operating at consistent speed, the trunk shaker harvested approximately 3 ton/hr without adverse affect on fruit quality. Conservative estimates suggest the trunk shaker harvest costs approximately $200/ton as compared to 2012 hand harvest costs estimated at $400/ton.

Canopy-Contact Harvester

A prototype canopy contact harvester, designed for jatropha (biofuel crop), was assessed in 2011 and 2012 in a hedgerow planting comprised of mechanically- and hand-pruned plots. The canopy contact harvester averaged 77% fruit removal; however, statistical comparison with hand harvested plots was not possible, in part because hand-pruned trees damaged the machine. The canopy contact harvester required 2-3 minutes harvest time per tree, and may yet prove to be of value to the olive industry.

Orchard Adaptation Strategies Studied

Orchard adaptation strategies for mechanical harvest have targeted both traditional plantings and the innovation of new orchard designs better suited for mechanical harvest.

<u>Implementation of Mechanical Pruning</u>: In 2011 and 2012, a hedgerow planting (12 x 18 ft; 202 trees/acre) at Nickels Soil Lab (Arbuckle, CA) was utilized to compare yield in mechanically-pruned and hand-pruned plots. Mechanically-pruned plots produced over 1.1 ton/acre more cumulative yield than hand pruned plots for an estimated >$1300/acre boost in crop value. Similar results were observed when mechanical pruning was compared to hand pruning in a traditional orchard (13 x 26 ft; 139 trees/acre) in Tulare County between 2008 and 2012. In this system, trees were mechanically topped at 12 ft. and hedged annually on alternate sides 6 ft. from the trunk. No significant difference in cumulative yield was observed between mechanically pruned and hand pruned plots from 2008 to 2012.

<u>Orchard Design Innovations</u>: Bill Krueger, Farm Advisor Emeritus, Glenn County, established the innovative hedgerow planting (12 X 18 ft; 202 trees/acre) at Nickels Soil Lab in 2001, utilizing four training techniques: i) conventional; ii) free trained espalier, iii) espalier woven in wire trellis, iv) espalier tied to trellis. Based on 10 years of data, tree training had no affect on yield or crop value. This planting continues to be of service to the olive research community, having housed mechanical pruning and mechanical harvest trials in the 2011 and 2012 seasons.

Mutually Beneficial Economic Interest Fosters Cooperation

The successful development of a mechanical harvester has relied on cooperation between university researchers and the two groups ultimately benefiting from the technology: the commercial harvester industry and the grower industry. Funding supplied by the California Olive Committee, the olive grower supported Federal Marketing Order, supported synergistic efforts between UC Davis Departments of Plant Science[1], Biological and Agricultural Engineering[2], Food Science and Technology[3], Agricultural Economics[4], and UC Cooperative Extension[5], University of Cordoba, Spain[6], and the harvester, grower[8], and processor industries[9].

Collaborative Team of Researchers and Cooperators:

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Olive Notes
August 2013

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